# Insights

A publication of the Ontario Forest Research Institute

Ontario Forest Research Institute
OFRI - IRFO


*Helping new forests grow:*

## A decade of vegetation management research in Ontario

*By Lisa J. Buse*

As forest industry in Ontario moves towards certification, it will need to demonstrate reduced dependence on herbicides. Awareness of the alternatives and their uses and limitations will become increasingly important.

Ontario has supported an active forest vegetation management research program for some time. In the early 1990s, as part of the Ontario's Sustainable Forestry Initiative, OMNR initiated the Vegetation Management Alternatives Program (VMAP), led by Bob Wagner, a former OFRI scientist now at the University of Maine, to more systematically evaluate forest vegetation management practices that could easily be integrated with other forest management activities. During the Timber Class Environmental Assessment (EA) proceedings in the late '80s and early '90s, herbicide use was one of many forest management-related discussion points, and the final EA Decision in 1994 mandated the search for alternatives (EA Term and Condition 102).

Since then, OMNR has continued to advance vegetation management research and promote integrated practices in Ontario. According to Bill Towill, senior forest practices specialist with OMNR's Northwest Science and Information office in Thunder Bay, "One of the major benefits has been increased awareness among forest managers that there are other alternatives out there; that we have expanded the toolbox from which they can choose the best tool for the task at hand. To some extent, we've changed the perspective from the conventional *cut, plant, and broadcast aerial spray* approach to include more options and more integration." Some highlights include:

- **Establishing an extensive network of vegetation management research trials throughout the province.** This network is now providing 10th-year crop response data for boreal species for treatments such as mechanical and chemical site preparation, broadcast aerial herbicide and ground herbicide application methods, and mechanical and motor-manual brushcutting. Data are also being collected on how these treatments affect plant diversity, downed woody debris, small mammals, birds, salamanders, and other ecosystem components. "In several studies, the effort is focused on systematically comparing the alternatives side by side on the same site conditions for Ontario crop species, so that we can definitively show both crop and ecosystem effects of the treatments," says Wayne Bell, an OFRI research scientist. Crop response data will be used to model the effects of vegetation management alternatives on wood supply as well as their relative effectiveness. These studies will also contribute to a growing body of knowledge that can be used to set "free-to-grow" standards tailored to site type and establishment treatments. Ecosystem effects data allow resource managers to better understand and thus minimize treatment effects on the environment. For more information about the remeasurement project, visit http://forestresearch.canadianecology.ca and click on *Active Projects - Fibre Production - Old Trial Remeasurement for IFM.*
- **Increasing our understanding of the competitive mechanisms of boreal plant species by producing autecology guides for species of interest and conducting interspecies competition and release trials.** Interestingly, a 1994 survey by Decision Research (copies

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*Cette publication technique n'est disponible qu'en anglais*

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available from OFRI) indicated that over 75% of the public of Ontario support the control of unwanted vegetation in forests, with the most acceptable method being clearing brush manually. However, according to Bell, "After 10 years of research, we are concluding that several of the species most competitive with young trees in the early years of plantation establishment in the boreal forest are herbaceous rather than woody shrubs and consequently not readily controlled by brushing. In later years, woody species become more important competitors." In addition, researchers have found that the sooner competition with boreal species is controlled, the better the volume growth over time.

- **Documenting forest ecosystem responses to alternative conifer release treatments.** According to R.A. Lautenschlager, a research scientist at OFRI and a co-leader with Bell in the Fallingsnow Ecosystem Project near Thunder Bay, "Our research has shown that herbicides are not any better or worse for the environment than the alternatives tested, and for several ecosystem components, herbicides actually resulted in fewer changes than the alternatives."
- **Identifying the effects of competing vegetation on early height growth of crop trees.** "Recent analyses of black spruce and jack pine height growth data from competition studies indicate that early height growth is affected by competition," says OFRI research scientist Michael Ter-Mikaelian. "We found that height growth rates are virtually identical for seedlings growing under various levels of competition after the first year, so management efforts should definitely be focused on the first year after planting." These data are also being used to develop a model that will predict early height and diameter growth of black spruce and jack pine for various site types. Modelling efforts have also focused on methods of assessing the effects of competition on tree growth. For example, according to Ter-Mikaelian, visually estimating percent cover in the field is as good a predictor of competition effects on the early growth of jack pine as more technologically advanced measurements such as assessing the amount of light reaching each seedling.
- **Investing in transfer and training to ensure resource managers in Ontario are kept up to date on the latest vegetation management information.** For example, "Research results were effectively transferred to operations staff by involving them directly in establishing and monitoring trials," says Andrée Morneault, a vegetation management specialist based at OMNR's Southcentral Science and Information office in North Bay. In addition:

  • From 1992 to 1994, Advanced Forest Herbicide Courses were run annually to help ensure resource managers were using herbicides as safely and effectively as possible.

  • Between 1993 and 1996, regional vegetation management workshops were held around the province to increase awareness of the possible alternatives and their advantages, disadvantages, and applications.

  • In 1998, the Third International Conference on Forest Vegetation Management was cohosted by OMNR and the Canadian Forest Service in Sault Ste. Marie to showcase their vegetation management efforts to Ontario and international audiences.

Photo by Wayne Bell

*Research on aspen cut height has given forest managers more control over aspen regrowth (see sidebar).*

Staff continue to transfer project results at workshops organized by both OMNR and partner agencies around the province. As well, technical notes, guides, and reports document studies installed and results to date, ensuring that the information is available to those who will need it in the future.

- **Implementing research results in operational forest management; for example:**

  • Ontario's forest industry and some OMNR districts are using results of a provincial season and height-of-cut comparison study to manage aspen more effectively – both to reduce the amount of aspen regrowth where conifers are desired and to increase the amount of aspen regrowth where wildlife habitat is the management objective (see sidebar).

  • In central Ontario, research not only confirmed that prescribed understory burning for red oak regeneration was a feasible alternative but also resulted in refined prescriptions for using this alternative effectively. Morneault says, "Not only does this treatment encourage red oak regeneration, it promotes its growth and vigour, providing it with a competitive advantage over other species that try to establish on the site. We're now using understory burning successfully to manage red oak in central Ontario."

  • In southern Ontario, much of the emphasis was in aiding and encouraging landowners and partners to increase the survival and growth of hardwoods in afforestation projects through the use of mulches and tree shelters, says Silvia Strobl, former forest specialist with OMNR's Southcentral Science and Information office in Kemptville. In addition to establishing demonstration areas and testing different kinds of materials, staff wrote and produced a series of landowner extension notes about the best ways to establish and maintain these high-value crops (available at http://www.mnr.gov.on.ca/MNR/forests/extension_notes/index.html).

  • Forest industry staff in the province are working to reduce the amount of herbicide applied to areas where these treatments are necessary by modifying spray nozzle size and ensuring treatments are timed for maximum efficacy. In addition, ground spray techniques focused on individual stems, such as basal bark injections, are being used effectively in some areas.

Some of the alternatives tested were less successful. For example, sheep grazing was proposed as a potential alternative to herbicides; however, there were operational problems in managing the herds, concerns about introducing diseases into wild ungulate populations, and concerns about site degradation, including soil and water quality issues. The sheep grazing idea was abandoned, but not necessarily because the sheep couldn't control the competition, but rather because they could harm the environment more than other alternatives.

Photo courtesy of OMNR Southcentral Science and Information

*Field tours are just one way new vegetation management information has been transferred to users in Ontario over the last decade.*

**Next steps for vegetation management researchers include:**

- Continuing to monitor long-term studies to increase our understanding of the long-term effects of various vegetation management practices on crop response and the environment and to provide background data for associated computer models
- Continuing to transfer results to improve forest vegetation management policies and practices
- Developing decision-support systems to help resource managers make more effective, informed decisions about whether vegetation management is needed and which tools are most appropriate in given situations; for example, a summary of Canadian pest and vegetation management-related literature has been compiled into an Internet-based, accessible database by Canadian Forest Service researchers working under the Forestry Research Partnership (details available at www.glfc.cfs.nrcan.gc.ca/cfpm)
- Establishing new integrated studies to test the cumulative effects of enhanced forest productivity practices on fibre production, plant diversity, and the environment over the long term (see related article about NEBIE on Page 7)

*For more information about (e-mail addresses are firstname.lastname@mnr.gov.on.ca) ...*

- *forest vegetation management research trials, contact Wayne Bell, OFRI, ext. 225*
- *associated modelling efforts, contact Michael Ter-Mikaelian, OFRI, ext. 221*
- *forest ecosystem responses, contact R.A. Lautenschlager, OFRI, ext. 228*
- *central or southern Ontario vegetation management trials, contact Andrée Morneault, Southcentral Science and Information, (705)475-5566*
- *boreal vegetation management trials, contact Bill Towill, Northwest Science and Information, (807)939-3103*
- *vegetation management policies, contact Mike Irvine, Forest Management Branch, (705)945-5724*

# Giving forest managers more control over aspen

***By Lisa J. Buse***

Even before researchers published studies about what time of year and how high to cut aspen to minimize (or maximize) regrowth, these results were being implemented on the ground by forest managers in central Ontario.

These recommendations include cutting in the fall at 25 cm aboveground to ensure maximum regrowth and cutting in mid-summer at 50 to 75 cm aboveground to reduce aspen regeneration. Traditionally, brushsaw cutting was done in the fall at ground level because the workforce was available and it's much easier to see where the stems are after the leaves are gone. However, this practice was not effective for crop tree release.

Jeff Leavey, general manager of the Ottawa Valley Sustainable Forest License in central Ontario, emphasizes that they use the aspen cut/height recommendations in their brushsaw contracts for manual tending work done in the mid-summer window on about 300 of the 800 hectares treated per year. "It's practical and effective and more cost effective than brushsaw with herbicide applicators, which is how we treat the remaining 500 hectares," Leavey says. In addition, Ottawa Valley has used sandviks and modified chainsaws in the summer window with some success. According to Leavey, "We're combining the research recommendations with available labour force and tools to our advantage."

Lori Costello, senior technician, Temagami Area, North Bay District, reports that the primary tending method in her area is now brushsaw cutting. A total of 2,400 hectares have been treated since 1996, with the season and height-of-cut recommendations being implemented as of 1999. The district plans to continue treating about 500 hectares per year this way.

Especially in central Ontario where forest management areas are smaller, more intensive management is feasible. Thus, alternatives that wouldn't be considered cost effective or practical in other areas are possible here. "Our forest management costs are already high, but in many cases we have good access, and we're dealing with high-value species, so we can afford to be a bit more intensive in our management practices," says Andrée Morneault, a vegetation management specialist with OMNR's Southcentral Science and Information office in North Bay.

As with all alternatives, there is a downside. Some wildlife biologists are concerned that this cutting method is too effective – and may be reducing moose and deer browse in some areas. In addition, leaving such high stumps can present hazards to forestry workers. Both these issues are being resolved by those applying the treatments, Morneault says. To address wildlife concerns, forest managers are limiting treatment areas and ensuring sufficient habitat exists nearby. Safety concerns are being addressed by planning cutting operations carefully, so workers don't have to travel back across treated areas.

*For a reprint of the article* Response of immature trembling aspen to season and height of cut *(N. J. Appl. For. 16(2):108-114), call the OFRI publication request line at ext. 271 or e-mail information.ofri@mnr.gov.on.ca.*

## OFRI STAFF PROFILE

Photo by John Pineau

# Wayne Bell

***By Abigail M. Obenchain***

If your image of a research scientist is someone who leads a solitary existence, squirreled away in a laboratory or office, then you haven't met Wayne Bell. Wayne, a forest ecology research scientist at OFRI, is never happier than when he is out talking to people, whether about forest research, plant ecology, backyard gardening, or the best spots for landing salmon in the St. Mary's River.

Even his favourite aspect of research relates to communication. "I really enjoy the design phase of research projects because it involves much discussion among the partners," Wayne says. "Some of the best transfer opportunities occur during this time, since many thoughts and ideas need to be debated before the final proposal is submitted."

Wayne has an MSc from Lakehead University and has worked for OMNR since 1988, with Northwest Science and Information in Thunder Bay for 4 years and with OFRI for the last decade. He is particularly interested in the effects of human disturbances on the ecology, diversity, and succession of forest plants. "My position at OFRI came about under the Vegetation Management Alternatives Program," he says. "This provided me with the opportunity to initiate such projects as the Fallingsnow Ecosystem Project, the Arboretum interspecies competition study (*Insights* Vol. 3, No. 1), and the Wharncliffe ecophysiology study (Vol. 3., No. 1, and Vol. 5, No. 1)."

Wayne is also providing scientific leadership for the new NEBIE project (see related article on Page 7), in partnership with the Upper Lakes Environmental Research Network (ULERN) and many other organizations, including forest companies, colleges, and universities. "Wayne understands the value and importance of collaboration and the work involved in keeping everyone on a project team on track," says ULERN director Margo Shaw. "He has the people skills and the dogged determination required to lead complex projects such as NEBIE."

Among his recent accomplishments are helping to author the autecology sections of OMNR's silvicultural guides, chairing the 1999 Intensive Forest Management Science Workshop in Sault Ste. Marie (the proceedings of which are available from OFRI as OMNR Science Development and Transfer Series Report No. 3), and, in conjunction with various partners, making the following scientific discoveries:

- Conifer growth can be accelerated by up to sevenfold with vegetation control.
- Cutting aspen higher (50-70 cm) on the stem in the summer is more effective in reducing sucker vigour than the traditional practice of cutting in late fall at ground level.
- Balsam fir, beaked hazel, and bracken fern must be controlled for white pine to survive and grow.
- Herbaceous species reach their maximum density much more quickly than woody species and are far more competitive with crop trees when growing on clay soil than sand.
- A heavy density of large-leaved aster will kill young jack pine growing on clay by showering the trees' needles with deadly *Coleosporum asterum* spores. However, jack pine can grow surprisingly well on clay in the absence of competition.
- Spore-producing plants are far more sensitive to disturbance than seed-bearing plants.

You can reach Wayne at OFRI at ext. 225 or e-mail him at wayne.bell@mnr.gov.on.ca.

# New knowledge of *Armillaria* ecology could help reduce timber losses

***By Abigail M. Obenchain***

Is Armillaria root disease a relentless destroyer of wood fibre or an important regulator of the ecosystem?

Both, says John McLaughlin, an OFRI research scientist. "This fungus has evolved with Ontario's trees throughout the ages. It is a wonderfully effective natural thinning agent, taking out weaker trees to free up space, light, and nutrients for more vigorous trees.

"It starts to become a serious problem for people, however, when it takes hold in more intensively managed stands, such as those in central and southern Ontario, in which much time and money have been invested. As forest management intensifies in northern Ontario, management of Armillaria root disease will become much more of an issue there as well. Armillaria could also become more of a problem if climate change causes more ice storms or droughts, as stressed trees are much more vulnerable to fungal infection."

According to McLaughlin, scientists don't know exactly how much wood is lost to Armillaria in Ontario each year; however, a joint OMNR-CFS study published in 1992 showed that root diseases, lead by Armillaria root disease, killed 8 million cubic metres of conifers every year during 1982-87 and reduced growth by nearly 700,000 cubic metres. Total pest losses averaged 31.8 million cubic metres per year. In contrast, 19.1 million cubic metres were harvested annually during that time.

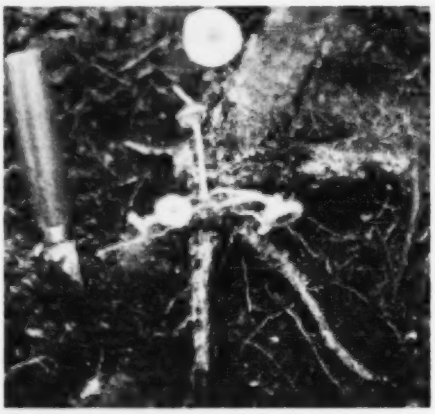


Photo by John McLaughlin

*If you find signs of* Armillaria *on a conifer in central or southern Ontario, especially in a conifer-dominated stand, it's probably* Armillaria ostoyae. *Of the six species found in the region,* A. ostoyae *is the most virulent and widely distributed.*

To provide forest managers in central and southern Ontario with a better understanding of Armillaria, McLaughlin undertook two studies in the late 1990s. The first study was a survey of the species, geographic distribution, host range, site relationships, and effects of *Armillaria* species in central and southern Ontario, and the second looked at the effects of Armillaria root disease on succession in red pine plantations in Simcoe County. Details on these studies follow.

**The *Armillaria* survey:** According to McLaughlin, it wasn't until the end of the 1970s that *Armillaria* was found to be a group of species that differ widely in which host trees they prefer and how they affect these hosts. (While all *Armillaria* species in Ontario are *pathogenic*, i.e., they can cause disease, some are more virulent and can kill hosts quickly on their own, while other, less virulent species are more *saprophytic*, i.e., they cause butt rot and live off dead plant tissue.) As of 1999, however, little information was available on the distribution of *Armillaria* species in central and southern Ontario, their host preferences, and their ecological relationships. Thus, that year McLaughlin set out to collect samples of *rhizomorphs* (root-like parts of the fungi that grow through the soil seeking other trees to infect) and infected wood from more than 100 forest growth and yield plots across central and southern Ontario and to sort out the site relationships related to *Armillaria*.

"Too often we talk about pathology just in the context of protection," he says. "Protection against losses to root disease can be best achieved through prevention, through avoiding creation of high-risk host species/site factor/pathogen combinations. I felt this survey could help us take a more proactive approach by providing a basis for developing a hazard-rating tool that could predict disease impacts on different sites and thus help forest managers choose appropriate species."

Key results of the survey include the following:

- Six *Armillaria* species were identified across the region.
- These species differed widely in how they were distributed. The most virulent, *Armillaria ostoyae*, had the broadest geographic range.
- The species of *Armillaria* occurring on a site were strongly associated with host tree species, soil texture, moisture regime, site drainage, and soil parent material. *Armillaria ostoyae*, for example, most commonly affected conifers and was the only species found on conifer-dominated sites, while the less pathogenic *Armillaria gemina*, found only in the northern part of the region, infected only hardwoods.

Because of the strong links between *Armillaria* species and various site factors, the study made McLaughlin even more convinced of the importance of knowing what species of *Armillaria* are present on a site before you try to manage for a certain crop tree species. "Prevention is the way to go in disease management," he says. "By understanding how the fungi interacts with the ecosystem, you can make choices that minimize your potential for losses. Once we have a hazard-rating tool in place, forest managers will be able to do this much more easily."

**The red-pine succession study:** Simcoe County has many red pine plantations that were established in the 1920s and '30s, mostly to rehabilitate so-called "blowsand areas" left barren by harmful logging practices and failed agriculture in the previous decades (see related article on managing succession in conifer plantations on Page 6). Through the years, periodic thinnings have provided income to the managing agencies as well as gradually opened the plantation canopies, allowing various hardwood and conifer species to take hold in the understory. Local forest managers are hoping this succession will reduce future need for artificial regeneration as well as reliance on clearcutting. However, other canopy gaps have been created by the expansion of Armillaria root disease centres, which have taken advantage of drought-related tree stress. Thus, forest managers have been concerned about lost income due to Armillaria-caused pine deaths and potential effects on the successful development of a mixedwood forest. In 2000, McLaughlin set out to investigate Armillaria root disease centres in 13 pine plantations in the county (1 was in adjoining Dufferin County). Here's what he learned:

- With the exception of black cherry, hardwood species tolerated Armillaria fairly well: Armillaria will kill or cause butt rot on some of the hardwoods but should not create treeless stand openings.
- Black cherry and sugar maple were the most important hardwood species to grow in the gaps, but white ash, red maple, red oak, and American beech were also common.
- The only conifer to colonize the openings in significant numbers was white pine, but most of it died quickly due to the double threat of Armillaria and white pine blister rust, which thrives in canopy openings like those produced by Armillaria (see white pine article in *Insights* Vol. 5, No. 1).

To break up disease centres and prevent them from growing, infected stumps and roots must be removed, a common practice in southern British Columbia where tree growth rates make it economically feasible. However, the economics of this practice for Ontario are unknown, and unless another rotation of conifers is planned for the site, stump and root removal is unnecessary.

Thus, to minimize losses and maximize profits, McLaughlin recommends that in intensively managed plantations where future conifer silviculture is not intended, forest managers watch for Armillaria symptoms in red pines around the outside edges of disease centres and remove symptomatic trees as well as a row or two beyond them. "This doesn't remove the pathogen, and it may eventually move through the roots and stumps to the next ring of trees around the disease centre, but at least this way, people get the timber rather than the fungus," he says. "As for the hardwood component, it will experience some growth loss and mortality but shouldn't require any significant intervention."

*For more information about this research, contact John McLaughlin at OFRI (ext. 246). Partners in the survey project include OMNR's Southcentral Science and Information office in North Bay and the University of Toronto and in the succession project include Simcoe County and Dufferin County forestry staff. Two articles on* Armillaria *are available from OFRI (call the publication request line at ext. 271 or e-mail information.ofri@mnr.gov.on.ca): 1)* Distribution, hosts, and site relationships of *Armillaria* spp. in central and southern Ontario *(Can. J. For. Res. 31:1481-1490) and 2)* Impact of Armillaria root disease on succession in red pine plantations in southern Ontario *(For. Chron. 77(3):519-524).*

Source: OMNR archives

*"This land in many cases was abandoned by farmers, reverted to bare mineral soil, and became desert-like 'blowsand' areas...."*

# Results of succession management study to help return former blowsand areas to "natural" forest

***By Abigail M. Obenchain***

"Before European settlement, most of the southern Ontario landscape was in forest," begins Ken Elliott, a Carolinian forestry specialist based at OMNR's Southcentral Science and Information office in London. "There were tolerant hardwood forests of sugar and red maple, American beech, yellow birch, and eastern hemlock, as well as mixed forests of white pine and red oak.

"After settlers arrived in the early to mid-1800s, much of this forest was cleared for farmland. But the drier lands formerly occupied by white pine and red oak turned out to be poorly suited for agriculture: The loss of trees and the coarseness of the soil lead to massive soil erosion and more frequent, severe spring floods and summer droughts. This land in many cases was abandoned by farmers, reverted to bare mineral soil, and became desert-like 'blowsand areas.'

"From about 1900 to 1920," he continues, "the Ontario government used legislation partnerships with counties to encourage people to rehabilitate these areas by establishing plantations, usually of red pine and other pine species that could grow well in the infertile, sandy soils. This effort succeeded dramatically; today, these former 'deserts' are now healthy, thriving forests, providing ecological, timber, recreational, and other benefits to the people of southern Ontario.

"In many areas, plantation management that was focused on maintaining growth and quality has resulted in the natural regeneration of native hardwoods and white pine. However, in 1993, a number of foresters who managed these plantations came together and decided that for a number of reasons they needed to figure out practical ways to accelerate the succession of these plantations to a more natural, diverse forest."

Photo by Dan Dey

*"... Today, these former 'deserts' are now healthy, thriving forest...."*

Photo by Ken Elliott

*Five years after underplanting, red oak seedlings are growing well.*

"Eventually, these plantations would convert to natural forest on their own as a result of canopy disturbances and arrival of tree seed from nearby woodlots via wind, birds, etc.," says Bill Parker, an OFRI scientist who has helped direct this project. "In older, previously thinned pine plantations, an abundant hardwood understory has established. But that process can take over 50 years.

"There's also a feeling by some that these pine plantations are not as ecologically desirable or aesthetically attractive as natural forest and are 'ecological deserts' with respect to biodiversity. So we wanted to see if we could use some combination of partial cutting and understory treatment to speed up the succession of these plantations to a more diverse forest."

Thus, a trial was established in the Durham Regional Forest, the objectives of which were to look at managing the successional process at two separate stages in the life of these plantations and to determine if certain approaches could speed the development of a more natural stand. The first experiment, reported on here, was designed to assess several first-thinning approaches and to see if underplanting is more successful than natural regeneration. The second experiment, still underway, is focused on testing different combinations of partial cutting and understory release treatments on the succession of mature red pine plantations. Here's what they've learned so far:

- Thinning young red pine plantations more heavily and considering conversion earlier than indicated by traditional plantation management guidelines resulted in valuable timber, helped reduce the plantation-like environment, enhanced growth of planted and natural tree seedlings, and increased biodiversity. "Clearly, you don't have to wait until the red pines are 60 years old to start the conversion process," Parker says.
- Well-planted seedlings performed well in red pine understories and provided a head start over natural regeneration.
- Growth increases with increased light; planting seedlings within canopy gaps promotes the greatest growth.
- All three of the planted species - white ash, white pine, and red oak - grew well, with white pine demonstrating slightly better potential without the dieback problems associated with the broadleaf species.
- Red oak seedlings grown from acorns had one third the survival rate of red oak planted seedlings, due primarily to predation by small mammals. Seedlings from planted acorns grew well but lagged behind the planted seedlings.
- After 5 years, about 70% of the ground in unplanted areas is bare of vegetation, regardless of the treatment.
- More than 100 plant species were found on the study site; thus, 30-year-old red pine plantations are not "ecological deserts." Unfortunately, about a quarter of these species are exotic and/or invasive. "Care must be taken to ensure these species do not affect the survival of other plants," Elliott says.

Results from the experiment in mature plantations are expected within 2-3 years.

*For more information, call the OFRI publication request line (ext. 271) or e-mail information.ofri@mnr.gov.on.ca and ask for* Managing succession in conifer plantations: converting young red pine *(Pinus resinosa* Ait.*)* plantations to native forest types by thinning and underplanting *(For. Chron. 77(4):721-734). Contact Bill Parker at OFRI at ext. 212, bill.parker@mnr.gov.on.ca, and Ken Elliott at (519)873-4626, ken.elliott@mnr.gov.on.ca. Other OMNR staff involved in this project include former OFRI scientist Dan Dey, now with the USDA Forest Service in Columbia, MO; Eric Boysen of OMNR's Forest Policy Section, Peterborough; and former OFRI scientist Steve Newmaster, now of the University of Guelph.*

# Ontario's Living Legacy Trust funds enhanced forest productivity study

***By Abigail M. Obenchain***

How much forest management is worthwhile for various types of forests? How do these varying levels of management affect productivity? Soils? Biodiversity? Carbon storage? Wildlife habitat? Non-timber forest products?

To answer these questions and more, the Ontario Living Legacy Trust recently awarded the Upper Lakes Environmental Research Network (ULERN) and its project partners $903,000, for use between October 2001 and March 2004, to initiate a research program known as the NEBIE plot network. This program will evaluate the effects of a range of practices - **n**atural, **e**xtensive, **b**asic, **i**ntensive, and **e**lite - for enhancing forest productivity in the boreal and Great Lakes-St. Lawrence forests in Ontario.

"There are so many myths and uncertainties about what various levels of forest management intensity can do," says Wayne Bell, an OFRI research scientist who is leading the science part of the program. "Through the NEBIE project, we hope to provide forest managers with a complete picture of the pros and cons of various options by forest type. We'll be looking at economics, species diversity, genetic diversity, structural diversity, coarse wood, pathology, entomology, soil properties and processes, non-timber forest products, and, of course, fibre production.

"Right now we have more than 30 people involved. It's very exciting because nothing like this has ever been done before in Ontario; however, I expect it will also be a huge challenge for all of us."

Planning for the NEBIE project has been underway for over a year. Four research sites have already been selected: a jack pine site near Sioux Lookout, a spruce/aspen/fir mixedwood site near Dryden, a white birch site near Wawa, and an aspen/white spruce mixedwood near Timmins. Other sites being considered include a mixedwood site near Sioux Lookout, an aspen site near Dryden, an upland black spruce site near Thunder Bay, a lowland black spruce site near Kapuskasing, white pine sites near North Bay and Petawawa, and a tolerant hardwood site near Algonquin Provincial Park.

Other partners/advisors in this project include forest industry (Abitibi-Consolidated, Algonquin Forestry Authority, Buchanan, Bowater, Clergue Forest Management, Domtar, FERIC, Nipissing Sustainable Forest License, Tembec, Weyerhaeuser), the Canadian Forest Service, academic institutions (Lakehead University, University of Guelph, Sault College, University of Alberta), and the Wildlands League.

The Living Legacy Trust is a 5-year, $30-million natural resources management fund established by the Ontario government in 1999 to help ensure that wood supply would not decrease after the increase in parks and protected areas through the Lands for Life process.

*For more information about the science portion of the NEBIE project, contact Wayne Bell at OFRI (ext. 225, wayne.bell@mnr.gov.on.ca). Other OMNR staff involved directly include Bill Cole, Sylvia Greifenhagen, Pengxin Lu, Jim McLaughlin, John McLaughlin, John Winters (OFRI-Sault Ste. Marie), Neil Stocker (Forest Management Branch-Sault Ste. Marie), Han Chen (OFRI- South Porcupine), Andrée Morneault (OFRI-North Bay), Murray Woods (Southcentral Science and Information-North Bay), Bill Towill (Northwest Science and Information-Thunder Bay), and Colin Bowling (OFRI-Kenora). For information on ULERN-administered projects, contact Margo Shaw at (705)759-2554, ext. 559, e-mail margo.shaw@saultc.on.ca, or visit www.ulern.on.ca/Projects/researchprojects.html. For more information about the Living Legacy Trust, visit www.livinglegacytrust.org or call toll free 866-LLT-3329.*

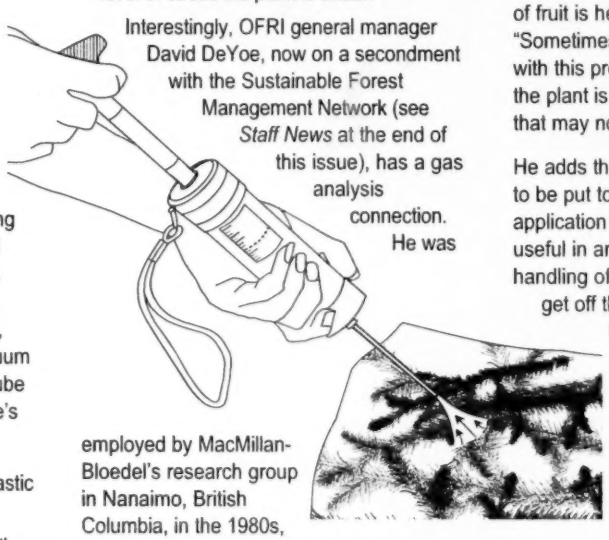
# OFRI scientist earns patent for test to detect "gassy" seedlings

*By Abigail M. Obenchain*

OFRI research scientist Steve Colombo and former OFRI researcher Colin Templeton have earned a U.S. patent for the stress-induced volatile emissions procedure (SIVE), a rare honour for an Ontario government science innovation (a Canadian patent is pending). This procedure detects seedling stress by measuring how much ethanol or acetaldehyde gas the trees are emitting.

According to Colombo, scientists have known for a long time that stressed plants give off gases, but the previous technology for assessing these emissions was expensive and complicated, and the equipment was cumbersome. The procedure he and Templeton developed uses a simple, portable system consisting of a vacuum pump attached to a glass analysis tube that resembles a thermometer. Here's how it works:

1. The seedlings are placed into a plastic bag to allow gases to accumulate.
2. The pump is used to draw air from the bag and into an analysis tube, which is filled either with a powder that turns blue if it encounters ethanol gas or a different powder that turns red if it meets with acetaldehyde gas, instantly indicating seedling stress.
3. The concentration of gas and thus the degree of stress is indicated by how much of the powder changes colour: The greater the amount of colour change, the higher the level of stress the plant is under.



Interestingly, OFRI general manager David DeYoe, now on a secondment with the Sustainable Forest Management Network (see *Staff News* at the end of this issue), has a gas analysis connection. He was employed by MacMillan-Bloedel's research group in Nanaimo, British Columbia, in the 1980s, when seedling quality was a major concern, and while there he found that stress-induced ethanol could be measured using the same breathalyzer technology police used to identify drivers who had been drinking.

Although the SIVE test was developed to assess stress in tree seedlings, it also works with produce and flowering plants and thus could be used in the horticulture, agriculture, and food industries. "Grocery store managers, for example, could use this application to determine if a shipment of fruit is healthy," Colombo says. "Sometimes a plant may look healthy, but with this procedure, stores can determine if the plant is damaged internally, something that may not be visible to the naked eye."

He adds that he is eager for this procedure to be put to commercial use. "This application has the potential to be very useful in any industry that involves the handling of plant material. I'd like to see it get off the shelf and be put to work. None of us likes it when we buy fruit that looks good but is rotten on the inside or a houseplant that dies a few weeks after we get it home. With this technology, we can help ensure that doesn't happen."

*For more information on the SIVE procedure or if you are interested in its commercial development, contact Steve Colombo at OFRI (ext. 218).*

## *Did you know...*

... that the SIVE procedure is just one of several innovative tests for determining the physiological health of tree seedlings that were applied by OFRI researchers during the 1990s?

These tests, which include chlorophyll fluorescence, root growth potential, and relative conductivity, are now administered by KBM Forestry Consultants, a private lab in Thunder Bay, Ontario, with OFRI staff providing quality control. Tree seedling growers or forest companies that want to ensure that seedlings for which they are responsible are problem-free can submit a sample for evaluation for a fee that is less than 1% of the cost of establishing an average plantation. Seedling Certification testing is used to confirm the suitability of stock for planting. Problem Stock Testing is performed when problems are suspected. Individualized testing programs are also available.

Over the past decade, these tests have prevented the planting of millions of unhealthy seedlings in Ontario.

*For more information on getting a tree seedling stocklot tested, contact KBM at (807)345-5445, ext. 34, e-mail sgellert@kbm.on.ca.*

# Old fire hoses get new life protecting microclimatic station cables in Ontario

***By Abigail M. Obenchain***

Cull fire hoses have made Brian Brown's job as a research technician at OFRI just a little easier.

He works with Bill Parker, an OFRI ecophysiology scientist whose research on seedling growth and vegetation competition depends on microclimate data related to variables such as solar radiation, wind speed, precipitation, air temperature, humidity, soil temperature, and soil moisture. The two collect this data using microclimatic stations, which consist of a battery-powered datalogger encased in a metal box and a set of environmental sensors that can be programmed to measure climate variables. The sensors are installed in the ground at various distances from the datalogger and connected to it with lengths of electrical cable.

*OFRI research technician Brian Brown displays a sample of the cull fire hose he uses to protect electrical cables that connect sensors to microclimate stations set up in research plots.*

Unfortunately, when these cables are left lying on the ground, rodents and other animals often chew on them. If suspended aboveground, they invite the attention of vandals and can obstruct field crews and large mammals. Researchers often bury the cables, but this approach is difficult in clay or rocky soil or areas with thin soil or extensive mats of tree roots. What's more, buried cables are vulnerable to damage by others working with shovels on site; digging can change the site in a way that affects research results; and it can be hard to find the cables again for repair or removal.

"There just had to be a better way to protect our data collection; it was getting ridiculous with all the time it took to bury the cables or to repair ones that weren't buried," Brown says. "And then it came to me: Why not use old fire hose to cover the cables? I had seen plumbing drainpipes used to cover cables at OFRI's arboretum, but we needed something portable, lightweight, and inexpensive that we could haul into the bush. When I contacted an OMNR regional fire centre, they had cull hose and were more than happy to give it to us."

Using cull fire hose to cover the cables has many advantages, Brown says, including:

- It protects very effectively: Researchers are seeing no more damage. Lined hose appears to be more durable than unlined hose.
- Covering cables with hose is much faster than burying or suspending it.
- The hose is easy to coil up and carry, can be cut to the proper length on site, and drapes easily over obstructions such as exposed roots.
- Hose-covered cables are easy to see, making it unlikely that soil samplers or tree planters will damage them with their tools.
- Cables that aren't buried or suspended are easier to repair, replace, and remove.
- Hose-covered cables stay much cleaner. "Just imagine what it is like to pull bare cables out of wet clay," Brown says.
- The hose was free, and using it in this manner gives second life to a product that would otherwise end up in a landfill.

According to Parker, use of microclimatic stations is increasing as scientists try to understand the ecological and physiological effects of management activities, natural disturbances, and climate change on forest ecosystems.

*To request a copy of* Using fire hose to protect microclimate station electrical cables in forest research *(OFRI Forest Research Note No. 60), which includes results of a study that compared the person hours required by the fire hose method vs. the traditional burying method, call the OFRI publication request line at ext. 271 or e-mail information.ofri@mnr.gov.on.ca.*

## *Coming next issue...*

- Results of the OFRI technology transfer survey
- Emulating natural disturbances
- How computer models fit into forest management
- The latest on the Bioindicators Project

# OFRI dives into forest soil and water research

***By Lisa J. Buse***

Although soil and water are recognized as basic building blocks of a healthy forest ecosystem, even today only limited basic soil and water quality information is available for northern Ontario. However, with the increased emphasis on assessing forest sustainability, and especially the mandate to protect and conserve Ontario's forest soil and water resources (Crown Forest Sustainability Act and Criterion 3 of Ontario's criteria and indicators evaluation framework), OMNR is developing a more extensive soil and water research program under the direction of OFRI scientist Jim McLaughlin.

According to McLaughlin, the program will focus on:

- Monitoring soil and water quality responses to disturbances in riparian zones, which occur where water meets land
- Assessing soil and water quality responses to varying levels of forest management intensity
- Measuring soil carbon cycling in boreal mixedwood forests in support of climate change research

## Do riparian reserves affect stream health?

"While earlier research by OMNR's Centre for Northern Forest Ecosystem Research (CNFER) has focused on lake ecosystems, we're looking at riparian zones along streams and rivers, in cooperation with CNFER and other agencies, and documenting their responses to forest harvesting and fire disturbances," McLaughlin says. "We also plan to look at the effect of harvesting on aquatic biodiversity, in particular periphyton mats, which are made up of algae, bacteria, and fungi and are very sensitive to environmental changes.

"Current resource management policies stipulate that a 30 to 90 m forested reserve remain around most streams, wetlands, and lakes. This may be producing shoreline forests dominated by shade-tolerant tree species that are not representative of natural boreal forest conditions, which is unacceptable," McLaughlin emphasizes. "We need to figure out how to manage effectively within riparian zones so as not to compromise associated ecosystems."

Studies near White River and Thunder Bay are looking at the effects of harvesting on soil nutrient cycling, groundwater, and stream water quality. The research partners have secured about $1.1 million from Ontario's Living Legacy Trust to support this research over the next 3 years. Results from these studies will be used to develop models of management, hydrochemistry, and water quality relationships for Ontario to ensure that forest management practices are not reducing stream water quality. Project partners for the White River study are the Canadian Forest Service, Sault Ste. Marie; Collège Boréal, Sudbury; and Trent University, Peterborough; for the Thunder Bay study they are CNFER and Lakehead University, Thunder Bay, and the University of North Carolina at Charlotte.

## How do varying levels of forest management intensity affect soil productivity?

As part of the NEBIE project (see article on Page 7), researchers will be monitoring how a range of forest management practices affect soil productivity. McLaughlin and his collaborators will investigate how these practices affect the chemical, biological, and physical properties of the soil, for example, how harvesting intensities affect soil nutrient cycling. Results will be used to identify sites where more intensive practices can be used without reducing long-term soil productivity.

"Monitoring and evaluating the effects of operational practices will ensure that these practices are changed if necessary," McLaughlin says. "In addition, I'll be working with other OFRI and Lakehead University researchers to incorporate the results into carbon cycling models that will help us to understand and manage climate change effects on forests."

## Are soil and water carbon fluxes changing?

We know that forests are important to global water cycles: Trees planted in wet areas have been shown to lower local water tables, and they are often planted along streambeds to control erosion. McLaughlin, working with the U.S. Forest Service and Michigan Technological University in Houghton, has found that plantations actually pull carbon from adjacent water sources into the soil. Thus, not only are the trees a carbon sink but also the soil in which they are growing, which indicates that soil carbon sequestering abilities will need to be incorporated into carbon cycle models to ensure that stored carbon is not underestimated.

McLaughlin also recently implemented a study near Foleyet, Ontario, in cooperation with the Canadian Forest Service in Sault Ste. Marie and Queens University in Kingston, to investigate how climate change affects boreal mixedwood carbon cycling. This study will examine the roles of fire and harvesting in mixedwood carbon cycling, and results will be integrated into a national effort to evaluate carbon cycling in Canadian forests. "We plan to integrate our efforts with carbon cycling work underway in the U.S. under the North American Carbon Cycle Program," McLaughlin states.

McLaughlin is quick to point out that OFRI's soil and water research program is still developing. A current priority for him and his partners over the next few years is to secure ISO certification for OFRI's environmental quality analytical laboratories, in which the soil and water samples from all of these studies are analyzed. Certification will not only increase the credibility of their results but also ensure their eligibility for external funding, both necessary for the success of this new research program.

*For more information about OFRI's soil and water research program, contact Jim McLaughlin (ext. 213; jim.mclaughlin@mnr.gov.on.ca) or Sandra Wawryszyn (ext. 117; sandra.wawryszyn@mnr.gov.on.ca).*

# Everything you ever wanted to know about regenerating Ontario's forests

*By Abigail M. Obenchain*

It all started with a dare on the stairs.

Scientist Steve Colombo was standing in a stairwell at OFRI in 1992 and listening to Bob Wagner, then also a scientist at OFRI, lament that Ontario, with its world-class forest research community and thriving forest industry, did not have a forest regeneration "bible." British Columbia had one, and so did Oregon and the southern United States, but not Ontario. As a result, people interested in forest regeneration had to obtain their information from scattered references published mainly in scientific journals and government publications.

So Colombo dared Wagner to work with him to put one together. And Wagner took the bait. The next thing the two scientists knew, they were organizing a massive undertaking involving more than 100 experts, including 35 OMNR staff from across the province, to pull together the latest information on both natural and artificial forest regeneration in the boreal and Great Lakes-St. Lawrence forests. The end result: the landmark 650-page *Regenerating the Canadian Forest: Principles and Practice for Ontario*, published in summer 2001 by Fitzhenry and Whiteside of Markham, Ontario (www.fitzhenry.ca).

According to Colombo, this book is an invaluable reference for any Canadian interested in forestry who lives east of the Rockies and even for forestry buffs in the northeastern United States. "Those other forest regeneration books have been around for about 20 years and are still in use," he adds, "so we think this one will have a good long shelf life."

*"Regenerating the Canadian Forest* is like a knowledge bank," says OFRI general manager Terry Taylor. "The contributors are people who have dedicated their professional lives to the advancement of forest regeneration practices. Their knowledge has been documented for the benefit of improving forest management and, specifically, forest regeneration in support of sustainable forests."

The 31 chapters of this book are divided into 8 sections: *History and Social Importance; Scientific Principles; Preparing the Site; Seedling Production and Establishment; Direct Seeding and Natural Regeneration; Stand Tending and Protection; Relation to Other Forest Resources*; and *Program Management and Monitoring*.

Colombo and Wagner wanted to make this book useful to practitioners and students as well as scientists, so they had it edited for plain language and worked with the publisher to keep the price down. It costs just $65, while many technical books sell for $200 or more.

As for the dare? Colombo has no regrets about his challenge to Wagner. Neither of them could foresee just how large a commitment they were making, but they feel that the end product was well worth the time and effort.

*For more information on* Regenerating the Canadian Forest: Principles and Practice for Ontario, *contact Steve Colombo at OFRI (ext. 218, steve.colombo @mnr.gov.on.ca) or Bob Wagner at the University of Maine (207-581-2903, bob_wagner@umenfa.maine.edu). To purchase a copy, call Fitzhenry and Whiteside at (800)387-9776 or visit www.fitzhenry.ca/a-forestry.htm. All OMNR district offices have a copy; limited additional copies are available to OMNR staff by e-mailing information.ofri@mnr.gov.on.ca (include an approved cost code).*

# Afforestation can help offset greenhouse gas emissions

*By Abigail M. Obenchain*

Under the Kyoto Protocol, Canada has pledged to cut its emissions of greenhouse gases to help slow climate change, and one of the most significant of these gases is carbon dioxide. According to OFRI researcher Marilyn Cherry, one way Ontario can help offset carbon dioxide emissions is through *afforestation*: establishing forests on lands that have not been forested for at least 50 years. "All forests are carbon sinks - they store carbon - thus, the more forested land Ontario has, the more carbon it can store," Cherry says. "Afforestation is also useful for reclaiming land degraded by mining or other industrial uses, landscaping urban environments, restoring ecosystems, and establishing wildlife corridors between forest fragments."

In a new OFRI report, titled *Options for allocating afforestation stock in Ontario with anticipated climate change*, Cherry explores the complexities involved in choosing which tree species and populations to plant, where and in what configurations, to maximize carbon storage. These complexities include:

- **Long- vs. short-term storage:** Fast-growing trees sequester more carbon in the short term but not necessarily over the long haul.
- **Block vs. scattered tree planting:** The former requires a land use change but sequesters more carbon and is easier to monitor for planting success and carbon sequestration.
- **The adaptability of various trees species/ populations to sites being afforested:** Cherry points out that "If climate change causes rapid changes in local environmental conditions, a seedling planted today may no longer be suited to the planting site at rotation age." However, current knowledge indicates that:
  - Northwestern Ontario will likely become warmer and drier. On drier sites, aspen will likely grow best, but jack pine may also do well. On moister sites, fast-growing white spruce and tamarack will likely be good choices.
  - In northeastern Ontario, many boreal and mixedwood species have high levels of genetic variability or are suited to varying habitats and thus will be well suited to this region if the climate warms.
  - Southern Ontario may lose some species as the southern boundaries of their ranges shift north. Eastern white pine, red maple, and green ash are species that will likely do well here if the climate changes.
- **Availability of land:** Northern Ontario has more and larger parcels of land available for afforestation. Southern Ontario's landscape and land ownership are highly fragmented, and thus afforestation efforts in this region will present greater challenges. However, Southern Ontario sites are more productive and can store carbon more quickly. "The challenge for land managers will be to find the balance between the carbon benefits of tree planting and all of the other values that private landowners and society have come to want from their forests," says Eric Boysen, OMNR's policy advisor for private land forestry, based in Peterborough. "Ontario's private land stewardship programs are designed to help find this balance – and would work well across the province."

**Continued on Page 12**

*Continued from Page 11*

Cherry concludes, "More knowledge is needed to accurately predict how species and populations will respond to changing climate. This includes better biological information and more regionalized climate models, as current global circulation models are not accurate at local scales. We also need a better understanding of the magnitude of the effects of climate change and of plant responses to the interactive or cumulative effects of various climatic variables that affect their growth and survival. Timing of climatic events may also be important (for instance frost events when the tree is flowering), and climate change may even affect mutation rates. Many research challenges are still ahead."

*To order a copy of* Options for allocating afforestation stock in Ontario with anticipated climate change *(OFRI Forest Research Information Paper No. 148), call the OFRI publication request line at ext. 271 or e-mail information.ofri@mnr.gov.on.ca. For more information on Ontario's investigation into afforestation in response to climate change, contact Eric Boysen at (705)755-5999, eric.boysen@mnr.gov.on.ca.*

# OFRI staff news

**Changhui Peng,** an OFRI scientist specializing in forest growth and yield and climate change research, has taken a leave of absence to work as an associate professor with the South Dakota School of Mines and Technology in Rapid City. He is slated to return in November 2002.

**Rob McAlpine, Corrinne Nelson,** and **Mark Parsons** are the newest members of OFRI's science management staff. All three are in acting positions:

- **Rob** is sitting in for **Vivienne Scott,** who has taken a temporary assignment with OMNR's Forest Fire Management Section. Rob has been with OMNR for nearly 6 years; his permanent position is fire science and technology program leader with OMNR's Forest Fire Management Section. He will return to that job in April 2002.
- **Corrinne** is sitting in for **Tim Meyer,** who is working as manager of strategic and organizational development for OMNR's Information Technology Services Branch until June 2002. Corrinne's home position is silviculture specialist with OMNR's Forest Evaluation and Standards Section. She has worked for OMNR since 1990.
- **Mark** is sitting in for **Terry Taylor**, who is now the acting general manager of OFRI (see below). Mark comes from the Ontario Management Board Secretariat's Shared Services Bureau, where he was a strategic procurement operations coordinator. He is scheduled to return to that position in October 2002.

OFRI general manager **David DeYoe** has taken a temporary assignment with the Sustainable Forest Management Network as manager of knowledge exchange and technology exploitation services. His return to OFRI is scheduled for October 2002.

**Terry Taylor** was the successful candidate to fill the acting general manager position during David's absence. Terry returned to OFRI in November 2001 from a 6-month secondment as the executive assistant to OMNR's assistant deputy minister of Forests Division; before that, he was on a 1-1/2 year secondment as the area manager with the Algoma District Team of the Northern Development and Mines' Northern Development Division.

# Upcoming events

**May 12-16, 2002: International Conference on Ecosystem Health: A Blueprint for Designing and Implementing an Integrated, Locally Based, Internationally Linked Global Change Monitoring Node,** Atikokan, ON. Sponsors: Quetico Centre, FedNor. Contact: (807)929-3511, qcmail@queticocentre.com, http://www.queticocentre.com.

**May 13-14, 2002: Emulating Natural Forest Landscape Disturbances: Concepts and Applications,** Sault Ste. Marie, ON. Sponsors: Ontario Ministry of Natural Resources, Canadian Forest Service, International Union of Forestry Research Organizations, Canadian Society of Landscape Ecology and Management. Contact: Terri Weaver at OFRI (ext. 201, e-mail terri.weaver@mnr.gov.on.ca). URL: http://www.landscape-ecology.com/enfd/index.html.

**June 25-27, 2002: Northeast Forest Ecosystem Classification Workshop,** Timmins, ON. This workshop will introduce forest managers and those interested in ecosystem classification to the new Forest Ecosystem Classification for Northeastern Ontario. For registration information, contact Gisèle Berry, Northeast Science & Information, South Porcupine, (705)235-1229, gisele.berry@mnr.gov.on.ca.

**August 5-7, 2002: Great Lakes Forest Soils Conference: Criteria and Indicators for Sustainable Forest Management.** Houghton, MI. Contact Jim McLaughlin at OFRI (ext. 213, jim.mclaughlin@mnr.gov.on.ca).

**August 9-14, 2002: 4th International Workshop on Disturbance Dynamics in Boreal Forests: Disturbance Processes and Their Ecological Effects in Boreal Forests,** Prince George, BC. Sponsor: University of Northern British Columbia. For registration information, contact Jennifer Studney (250-960-5520, studney@unbc.ca). For program information, contact S. Ellen MacDonald (780-492-3070, BorealDist@afhe.ualberta.ca). URL: http://www.res.unbc.ca/borealdisturbance/index.html.

**September 29-October 3, 2002: CIF/IFC Annual Meeting: Forests Sustaining Communities - Communities Sustaining Forests**, North Bay, ON. Technical program topics: aboriginal forestry, certification, private land forestry, forest communities, ecology and silviculture, stock production, forestry education, non-wood products, fire, and information technology. For more information, contact Fred Pinto (705-475-5563, fred.pinto@mnr.gov.on.ca) or Wally Bidwell (705-235-9480, wbidwell@ntl.sympatico.ca). URL: http://www.cif-algonquin.org/Hampco.html.

**November 13-15, 2002: Advances in Forest Management: From Knowledge to Practice**, Edmonton, AB. Sponsor: Sustainable Forest Management Network. For registration information, contact Alison Boddy (780-492-8037, alison.boddy@ualberta.ca). For program information, contact Peter Duinker (902-494-7100, peter.duinker@dal.ca). URL: http://sfm-1.biology.ualberta.ca/english/events/enetconferences.htm.

**Have a suggestion?**
**Want more information on a research project?**

## We want to hear from you!

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